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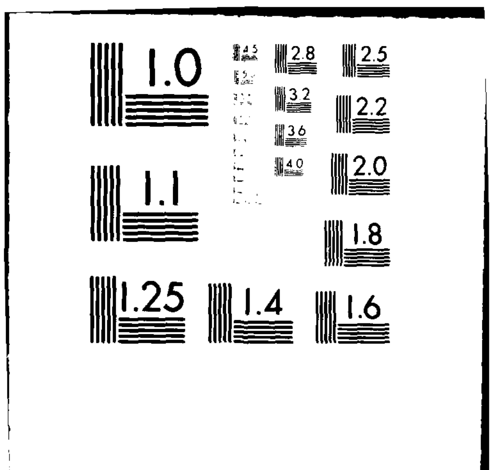

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Video Teleconference Design Evaluatio

Paul J. Stich
John F. Patterso

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Prepared for
Office of the Assistant Secretary of Defense
Manpower Reserve Affairs and Logistics
Washington, D.C. 20301
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VIDEO TELECONFERENCE DESIGN EVALUATION

by

(10)

Paul J. Sticha and John F. Patterson

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The Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics (OASD, MRAL) plans to improve productivity by taking advantage of recent technological advances in the following areas: video teleconferencing facilities, database management, and word processing systems. The benefits of technological advancement cannot be obtained without considerable investment. In order to make the most cost-effective decisions, MRAL has contracted for several studies in the three areas

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This study did not determine whether or not MRAL should purchase a teleconference system or how much money should be allocated for such a system. To assist MRAL in their goals, future research at DDI will involve designing a model which compares various teleconference systems to alternative systems which do not involve video teleconferencing, and obtaining more detailed cost estimates for a specific teleconference system.

SUMMARY

The Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics (OASD, MRAL) plans to improve productivity by taking advantage of recent technological advances in the following areas: video teleconferencing facilities, database management, and word processing systems. The benefits of technological advancement cannot be obtained without considerable investment. In order to make the most cost-effective decisions, MRAL has contracted for several studies in the three areas listed above. This report describes work performed by Decisions and Designs, Inc. (DDI) to investigate the costs and benefits of a large number of video teleconferencing configurations. The purpose of this investigation was twofold: to find those configurations which best match the needs of MRAL, and hence offer the greatest benefit given the amount invested; and to document the benefits of various teleconferencing systems to determine the overall value derived from teleconferencing.

This study did not determine whether or not MRAL should purchase a teleconference system or how much money should be allocated for such a system. To assist MRAL in their goals, future research at DDI will involve designing a model which compares various teleconference systems to alternative systems which do not involve video teleconferencing, and obtaining more detailed cost estimates for a specific teleconference system.

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VIDEO TELECONFERENCE DESIGN EVALUATION

1.0 INTRODUCTION

Recent technological advances have made it possible to improve greatly the productivity of the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs, and Logistics (OASD, MRAL). Developments in several areas make these improvements possible in all levels of management:

- Office video teleconferencing facilities give top-level MRAL officials the capability for high-quality communication without the high costs of scheduling and travel.

- Database management systems allow rapid access to information and poignant analysis of its implications.

- Advanced word processing and other electronic equipment of the office of the future provide for timely production, editing, and distribution of information.

The benefits of technological advancement cannot be obtained without considerable investment. In planning its development, MRAL must make those investments which give the maximum benefit from the amount invested. In order to make informed decisions in these areas, MRAL has contracted for several studies regarding office of the future, database management, and teleconferencing.

This report describes work done by Decisions and Designs, Inc. (DDI) to investigate the costs and benefits of

a large number of video teleconferencing configurations. The purpose of this investigation was to find those configurations which best match the needs of MRAL, and hence offer the greatest benefit given the amount invested. The approach used DDI's expertise in teleconferencing and in the methodology of decision analysis. Decision analysis is a set of techniques which aid a decision maker in solving decision problems when faced with complexity, conflict, or risk. The specific methodology used provides a framework for making decisions in which a limited resource must be allocated among competing programs. This methodology is often used for problems of budgeting and system design.

A second purpose of this project is to document the benefits of various teleconferencing systems and thereby determine the overall value derived from teleconferencing. Results of this analysis will make possible comparisons of investments in the areas of teleconferencing, office of the future, and database management systems. Details of this analysis will not be described in this report.

A video teleconferencing system is a complex one comprising many relatively independent parts. The numerous system components vary in degree of sophistication, and this variation is possible in the following four general areas:

(1) The audio-visual channel connecting the conferees - Enhancements in this area include large-screen color displays, virtual space organization, and inclusion of sufficient displays to accomodate large meetings.

(2) Data display and storage - This capability may be enhanced in a variety of ways, including providing color graphic displays with overlay control, highlighting, variety of input sources, and local video storage.

(3) Number of sites - The number of sites may be as low as four and as high as thirty-five.

(4) Central switching and storage sophistication. Enhancements in this area include providing a variety of central inputs to the data display system such as optical and magnetic video disks, and video tapes.

With such a large number of independent system choices, there are many thousands or even millions of potential system designs. The decision-analytic model developed in this project reduces the number of designs by identifying those offering the greatest benefits for the cost. This much smaller number of cost-efficient designs may be used as a menu from which to select a final teleconference system design. The general procedure used to structure the problem, assess costs and benefits, and identify cost-efficient designs is described in Section 2.0. The application of this procedure to the problem at hand is described in Section 2.0. Finally, Section 4.0 describes the conclusions of the work accomplished thus far and that which is planned for the remainder of the contract.

2.0 TECHNICAL APPROACH

The major problem in video teleconference system design identified above is the efficient allocation of limited investment resources to obtain the maximum benefit for the investment cost. The technical approach to this problem is described below.

2.1 General Approach

One of DDI's methodological approaches to resource allocation is benefit-cost analysis. The modeling software used to implement this approach is called "Design." Design's basic building block is a "variable"; a Design variable is one of the projects/programs competing for limited resources. In this case, the Design variables are the system components which may be more or less sophisticated. Each competing variable is itself defined in terms of "levels" describing increasingly costly options for it; one level must be selected by the decision maker for each variable. Finally, each level is described in terms of its cost (resource use) and benefits relative to other levels. A fully defined collection of Design variables that compete for the same resource is called a Design "model." In addition to the foregoing structural definitions, any resource allocation decision, that is, any choice of one level for each variable in the model, is called a "package."

Building a Design model involves identifying a set of variables and levels and assessing costs and benefits for each level so that the total cost and benefit for any package may be calculated. A simple version of the Design methodology assumes that the costs and benefits for different variables are independent. This means that a single cost and benefit may be assigned to each level so that the cost

and benefit of a package is the sum of the costs and benefits of its constituent levels.

The necessary conditions for intervariable independence do not hold in the present case or any problem in which there are variables representing both quantity and quality. For example, the cost of equipping twelve sites with video teleconference stations depends on the cost of the individual stations. However, individual station cost depends on the levels chosen for several Design variables.

The interaction mentioned above has two implications on the nature of the calculations which derive the cost and benefit of a package from those of each of a number of levels. The first implication is that the variables must be evaluated in a fixed order. The cost of a given number of teleconference sites cannot be assessed until the quality of the sites has been determined. The second implication is that certain variables have costs or benefits which serve to multiply the costs or benefits already assessed. In the example, there may be a fixed cost for a given number of sites, but the major cost is just the cost of a single site multiplied by the number of sites. The Design methodology used for this problem considers both fixed and variable costs for each Design variable.

The Design methodology and software have several functions in evaluation of system configurations:

- o to organize, display, and update experts' judgments about the relative costs and benefits on each level of each variable in the model;

- o to display the overall cost and benefit of any one package compared to other packages;

- to compute and display the "efficient frontier" of designs for the model, i.e., those key designs among all possible designs that provide maximum benefit for the amount of resources the yse; these designs are the key options to consider, but they are difficult to find without the computer's assistance;

- to display the levels of each variable for designs providing the greatest benefit for any given level of overall resource expenditure; and

- to compare different designs proposed by decision makers with more efficient designs that either cost less and provide the same overall benefit or provide more benefit for the same cost.

This technical approach serves to organize the options of experts on a variety of technical issues so that decision makers may determine the implications of these judgments on critical decision variables. Furthermore, it reduces the huge number of potential designs under consideration to a reasonable set of cost-efficient designs.

2.2 Procedural Steps

There are four steps involved in the development of a Design model: structuring the problem, assessing costs and benefits, identifying cost-efficient options, and exercising the model. Although these steps are listed in their logical order, there are usually many interactions among them. That is, problems encountered in assessing values may lead to restructuring the model, and exercise of the model may lead to changing the assessed values or even the problem structure.

2.2.1 Structure the problem - The task of problem structuring involves determining the set of variables and levels which characterize the range in sophistication available in the system design. The problem must be structured in a way compatible with the methods of analysis; that is, necessary independence conditions must be met. One useful way of arriving at a problem structure is by defining a baseline or least sophisticated system and a "gold plated" or more sophisticated system. These two systems define the upper and lower limits of acceptable system designs. Differences between these two systems often suggest the variables to be considered. For each variable, then, levels are defined which are intermediate between the baseline and the "gold plated."

2.2.2 Assess costs and benefits - The second step in model development is the assessment of model parameters. This step involves determining the dependencies between variables and the consequent order of variable evaluation, assessing fixed and variable costs and benefits for each level, and recording rationale for the assessments made. For each level there are two cost and two benefit parameters. Two of the parameters are a fixed cost and a fixed benefit. The other two are cost and benefit multipliers. The multipliers serve the dual functions of specifying the relative importance of benefits associated with different variables and describing the nature of the interactions between variables. Details of the assessment procedure are discussed in the next section along with the teleconference Design model.

2.2.3 Identify cost-efficient allocations - The set of cost-efficient allocations of resources is identified by using the costs and benefits assessed. The cost-efficient allocations are those which are not inferior to another allocation in both cost and benefit. That is, a package is

cost-efficient if there is no other package that is both less costly and more beneficial.

2.2.4 Exercise the model - Proposed allocations are compared to the set of optimal allocations. Sensitivity of allocations to model inputs are examined until the experts involved are satisfied with the model inputs and the resultant model allocations. Exercise of the model may lead to changes in the assessed costs and benefits or even to changes in problem structure.

3.0 THE TELECONFERENCE MODEL

3.1 The Model Structure

The analysis of teleconference system designs begins with the identification of factors that can vary from one design to another. Collectively these factors, or variables, are called the structure of a design model. Eventually, once the costs and benefits of these design changes are assessed, a cost/benefit analysis of the alternative designs can be conducted.

Figure 3-1 depicts the general design for a teleconference system. At the core is a central video switching unit that routes the information to and from various teleconferencing sites. There can be any number of such sites. In addition, the sites can differ in terms of whether or not a connection to a staff is available. Although the figure suggests that both types of sites will exist within a single design, the current model does not actually permit this possibility. Instead, all sites are specified as having a common design, which may or may not include a staff. This should become clearer as the model structure unfolds.

Figure 3-2 presents the basic strategy behind the construction of the teleconference design model. It is essentiallly a hierarchical decomposition of the overall design analysis into several subordinate analyses. The overall design consists of both an analysis of central switching features and an analysis of the peripherals that will be supported. The peripheral design consists of a determination of the number of peripheral sites and the quality of these sites. And, finally, the quality of any site is provided by an analysis of the confereee surrogate (the equipment for providing interpersonal communication) and an

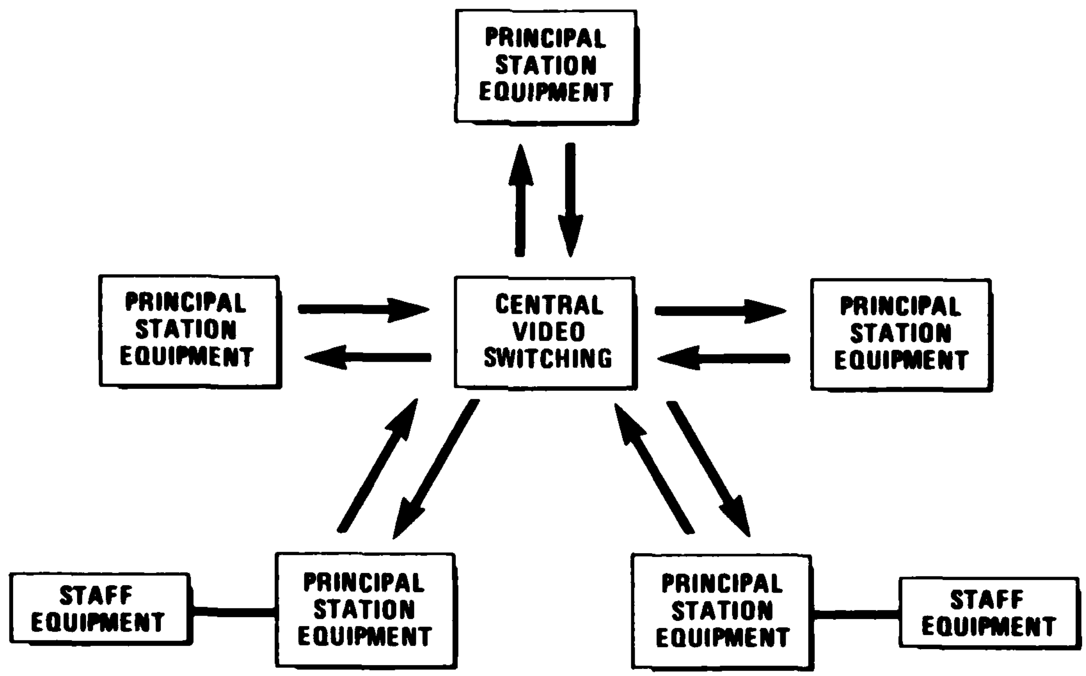

Figure 3-1

OVERVIEW OF TELECONFERENCING DESIGN
(Two Principals with Channels to their own Staff)

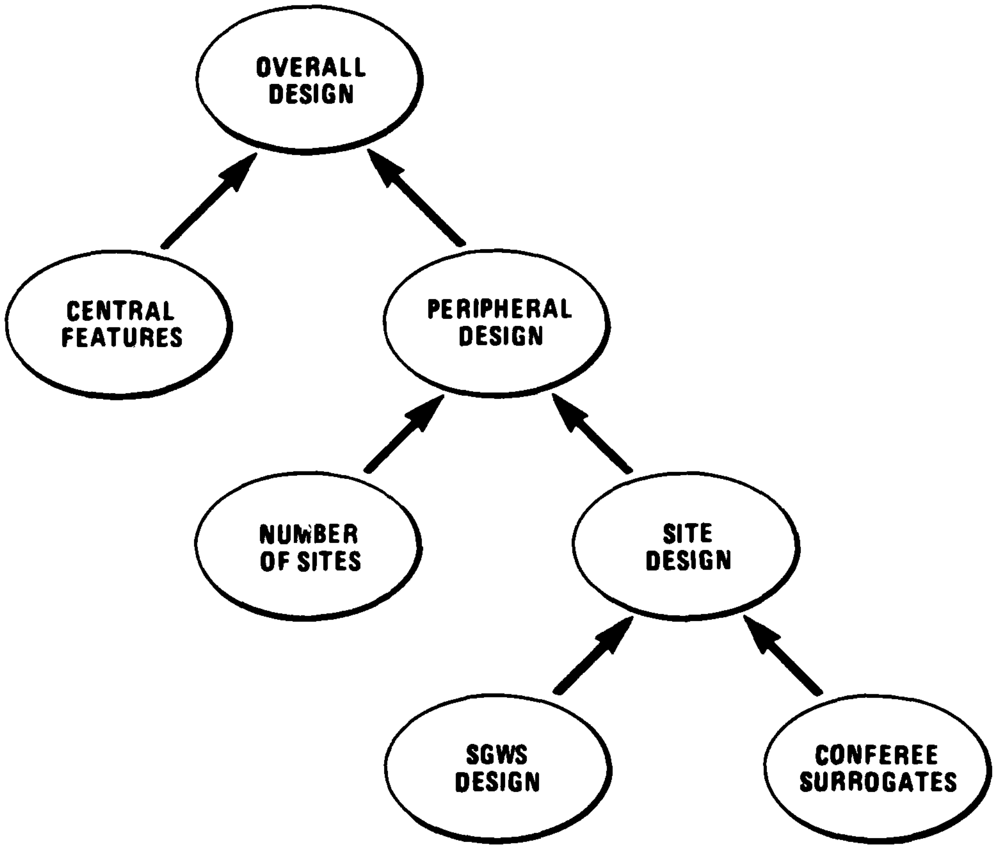

Figure 3-2

STRATEGY FOR TELECONFERENCE DESIGN EVALUATION

analysis of the shared graphical work space (SGWS; a monitor that is used like a blackboard for presenting graphical information). Each of these analyses is discussed below starting with the lowest level models.

3.1.1 The surrogates model - The model for the surrogates design consists of four factors, which are depicted in Figure 3-3. The first of these factors addresses the issues of how many surrogates will be provided. This, of course, determines the maximum number of participants in a teleconference.

The baseline surrogate design consists of all that is needed to conduct a simple teleconference. This consists of two black and white monitors using small screens. One video camera at each station provides the input to the monitors, and a microphone and two speakers are provided. (Elaborations upon this simple design are discussed below.) The maximum level was designated as five surrogates because of the difficulty of arranging so many monitors in front of a conferee.

The next factor of the surrogates model is concerned with whether eye contact will be available. To obtain eye contact, it is necessary to associate a camera with each video monitor. Thus, each viewer can receive the image of the camera associated with the monitor containing his image. The alternative is to provide only one camera at a station and route this single image to all conferees.

An additional benefit besides eye contact is the sense of spatiality that has been dubbed "virtual space." Given a camera for each monitor and assuming a generally circular arrangement of the monitors, it is possible to enhance the impression that all conferees are seated at a circular table. This is done by carefully routing the video

VARIABLE	1	2	3	4
1 NUMBER SURROGATES	TWO	THREE	FOUR	FIVE
2 VIRTUAL SPACE	NO VS	YES VS		
3 BW/COLOR	BW	COLOR		
4 SIZE	SMALL	LARGE		

Figure 3-3

CONFEREE SURROGATE MODEL STRUCTURE

images so that each conferee receives and transmits images in a consistent manner. Thus, if one conferee has another's image to his right, then the second conferee will have the first conferee's image to his left. Maintaining this sense of spatiality helps the conferees to determine who is being addressed at any instant.

The final two factors of the surrogates model are quite straightforward. The first simply reflects the possibility of obtaining black and white or color monitors. The second reflects the possibility of different size monitors.

3.1.2 The SGWS model - The shared graphical work space (SGWS) permits conferees to display information for discussion. A baseline SGWS is envisioned as consisting of an overhead camera at each station, which can be used to pick up information for display on black and white monitors in front of each conferee. This simple SGWS is quite austere, and the purpose of the SGWS model is to determine how the SGWS could be improved.

The SGWS model consists of the seven factors depicted in Figure 3-4. The first of these factors addresses the question of how the user will control the SGWS. At the simplest level this is a matter of providing switches to turn the camera on and off. At the next level a keyboard can be added, which now permits the user to access and control a computer. This would allow data in the computer to be routed to the SGWS. The next level of refinement is to add a touchscreen, allowing easier interaction with a computer and permitting highlighting of the SGWS display. The final improvement is to add a data tablet, which permits a natural medium for drawing sketches.

VARIABLE	1	2	3	4	5
1 SWITCHING/ INPUT	HARD SWITCHING	+ KEYBOARD	+ TOUCHSCREE	+ DATA TABLET	
2 PRIMARY MONITOR	B/W SIMPLE RASTER	COLOR SIMPLE RAS	B/W FRAME BUFFER	COLOR FRAME BUFF	
3 PREVIEW MONITOR	NONE	B/W SIMPLE RASTER	COLOR SIMPLE RAS	B/W FRAME BUFFER	COLOR FRAME BUFF
4 CONTROL MONITOR	NONE	ALPHANUMER IC			
5 STORAGE FACILITY	CENTRAL ONLY	CENTRAL AND LOCAL			
6 HARD COPY FACILITY	CENTRAL ONLY (COLO	CENTRAL + B/W LOCAL	CENTRAL+CO LOR LOCAL		
7 CONTROL LOCUS	PRINCIPAL	STAFF			

Figure 3-4

SGWS MODEL STRUCTURE

The primary monitor factor captures two ways in which the primary monitor of the SGWS can vary. On the one hand this monitor can be either a black and white or color CRT. On the other, it can be either a simple raster device or it can have a frame buffer. A frame buffer stores a video image and automatically refreshes the CRT. In addition, it can be quite useful for mixing different types of video information, e.g., highlighting, split screens, etc.

The preview monitor is a second CRT that permits a conferee to examine his material before he transmits it to the teleconference. In addition to the issues of color and frame buffer identified above, there is also a question of whether a preview monitor is necessary. Thus, the five levels for this SGWS factor begin by assuming no preview monitor and then proceed through the same four levels identified for the primary monitor.

The control monitor is a third CRT that could be provided at a teleconference station. This monitor provides a simple alphanumeric display and would be used to communicate with a computer. Another potential use for this monitor is to convey printed messages between the conferees.

An important capability for the SGWS is the ability to store video images that have been presented on the SGWS. While it can be assumed that a central storage facility will be available, it is conceivable that the individual conferees will want a local storage facility. This could be used either for storing briefing materials or for documenting a meeting.

Another important capability is the ability to create hard copy of a SGWS display. As with the storage facility it can be assumed that a central hard copy capability is available. The issue is whether local hard copy in either black and white or color is desirable.

The final factor in the SGWS model is that of control locus. Given the potential complexity of the SGWS, it is likely that a staff will be needed to reap its full benefit. In the event that a staff is added, a communication link between it and the principal will be provided. In addition, most of the extra SGWS capabilities would be placed under the staff's control.

3.1.3 Number of sites - The surrogates model and SGWS model together comprise the site design model. This reflects the quality of the teleconference stations. The full model of the principal design includes one additional factor: the number of sites.

The number of possible teleconference sites has been specified as being either four, eight, twelve, or thirty-five. Of course, at any one time, only three to six conferees could engage in a conference. There could, however, be several conferences at one time.

3.1.4 Central features model - The final component of the overall teleconference analysis is the central features model. The baseline design for the central features consists of all necessary video switching under processor control and a color hard-copy facility. The factors of the central features model represent improvements upon this basic design.

Figure 3-5 presents the three optional central features. The first anticipates the possibility of incorporating an optical video disk into the teleconference design. This would permit access to a large number of fixed prestored video images such as maps, aerial photography, etc., which could be routed to the SGWS's. Because of the large number of possible images, it is desirable to place the video disk under computer control. Manual control is, however, available.

VARIABLE	1	2	3
1 OPTICAL VIDEO DISK	NONE	MANUAL (R/O)	PROCESSOR (R/O)
2 MAG. VIDEO DISK	NONE	BUY	
3 VIDEOTAPE	NONE	BUY	
4 CENTRAL FIXED COSTS	FIXED COSTS	DUMMY	

Figure 3-5

CENTRAL FEATURES MODEL STRUCTURE

A second central feature anticipates the inclusion of a magnetic video disk. Compared to an optical video disk, the magnetic video disk has considerably less storage (about 200 as opposed to 54,000 frames of video). It does, however, provide a write capability, which is unavailable on the optical video disk. Such a video storage capability would be essential for retaining ad hoc video images that are generated during a meeting; it would also be necessary for storing briefing materials.

The final central feature entertains the possibility of including a videotape recorder at the central switching site. Such a device could be very useful for storing a record of the meeting. This could be used later to recall the decisions that were made or for restarting an unfinished meeting. A voice-activated switch could be used to determine which image to record at each instance. Alternatively, a split screen might be employed.

3.2 Assessed Costs and Benefits

Final assessments of costs and benefits for various system components were obtained in several steps. An initial model was developed and briefed to MRAL personnel. The parameters of this model were assessed by DDI teleconference experts and decision analysts. Some important parameters, for example, benefit weights, could only be assessed by MRAL personnel. These weights were assessed in a working session with MRAL personnel and DDI decision analysts. Initial assessments, MRAL assessments, and model results were used to refine the weights into their final form, which is presented in this section.

3.2.1 The surrogate model - The many interactions among the variables of the surrogate model made it impossible to represent accurately total cost and benefit using any of

the available Design model software. As a result, the surrogate design was handled by a separate analysis. The cost-efficient surrogate designs identified by this analysis were placed into the overall analysis, along with their calculated costs and benefits. Interactions occurred in costs, system benefit was an additive function of component benefits within the surrogate model.

Costs involved with different surrogate configurations are given by equation (1) and (2) for configurations without eye contact and with eye contact, respectively. The cost in equation (1) reflects the fact that when there is no eye contact, a single camera is sufficient at each teleconference site.

$$\text{COST} = (\#\text{SURR} \times \text{DISP}) + \text{CAM} \qquad (1)$$

Variables are defined as follows: #SURR represents the number of surrogates. DISP represents the cost of the display; this value depends on the size of the display as well as whether the display is black and white (BW) or color. CAM represents the costs of a single video camera. This cost depends on whether the displays are BW or color.

When there is eye contact or virtual space, each surrogate includes a camera as well as a display. The cost of the surrogate configuration is given by equation (2).

$$\text{COST} = \#\text{SURR} \times (\text{DISP} + \text{CAM}) \qquad (2)$$

Variable names have the same meaning in this equation as in equation (1).

The estimated costs for the surrogate model are shown in Table 3-1. These costs represent equipment costs

Item	Estimated Costs
Black and White Camera	$ 400
Color Camera	$ 900
Small Black and White Display	$ 400
Large Black and White Display	$ 600
Small Color Display	$ 500
Large Color Display	$ 900

Table 3-1

COST ESTIMATES FOR SURROGATE MODEL

alone and do not include costs of installation, operation, or maintenance.

Benefits for the surrogate model were represented as the weighted sum of the benefits assessed for each component. The benefits for each component were assessed on a relative scale in which the least beneficial level received the score 0, the most beneficial received the score 100, and other levels received intermediate scores in proportion to their benefit. In addition, weights were assessed to relate the range in benefit in one variable to the ranges in the other variables. The assessed benefits and weights are shown in Table 3-2. Rationale for the benefit scores is given in Appendix A-1.

3.2.2 The SGWS model - The variables of the SGWS model were constructed to have independent costs. With the exception of a single variable, the benefits are also independent across variables. The single dependency exists between the locus of control and the other SGWS variables. (Locus of control will be discussed separately.) For other variables, costs were assessed for each level, and benefits and benefit weights were assessed in the manner described in the previous section. These costs and benefits are presented in Table 3-3. Rationale for the benefits for all SGWS variables is presented in Appendix A-2.

The benefits assessed for the SGWS features assume that these features are easily controlled by the principals. For most of the features, this requirement necessitates the transfer of control to a staff who functions as an intelligent interface between the principal and the system. It was judged that improvements in system sophistication would not be effective without the introduction of a staff to control these improvements. On the other hand, the least sophisticated system was simple enough that a staff was not

Variable	Level				Weight
	1	2	3	4	
Number of Surrogates	0	60	90	100	100
Virtual Space	0	100			50
BW/Color	0	100			10
Size	0	100			30

Table 3-2

ASSESSED BENEFITS AND WEIGHTS FOR SURROGATE MODEL

VARIABLE 1: SWITCHING/ INPUT

		COST	BENFT
1	HARD SWITCHING	0	0
2	+ KEYBOARD	1000	40
3	+ TOUCHSCREEN	3000	90
4	+ DATA TABLET	4500	100
	WITHIN CRITERION WEIGHTS		60

VARIABLE 2: PRIMARY MONITOR

		COST	BENFT
1	B/W SIMPLE RASTER	2300	0
2	COLOR SIMPLE RASTER	3400	20
3	B/W FRAME BUFFER	14000	60
4	COLOR FRAME BUFFER	15000	100
	WITHIN CRITERION WEIGHTS		100

VARIABLE 3: PREVIEW MONITOR

		COST	BENFT
1	NONE	0	0
2	B/W SIMPLE RASTER	800	50
3	COLOR SIMPLE RASTER	1200	65
4	B/W FRAME BUFFER	14000	85
5	COLOR FRAME BUFFER	15000	100
	WITHIN CRITERION WEIGHTS		10

VARIABLE 4: CONTROL MONITOR

		COST	BENFT
1	NONE	0	0
2	ALPHANUMERIC	500	100
	WITHIN CRITERION WEIGHTS		20

VARIABLE 5: STORAGE FACILITY

		COST	BENFT
1	CENTRAL ONLY	0	0
2	CENTRAL AND LOCAL	30000	100
	WITHIN CRITERION WEIGHTS		5

VARIABLE 6: HARD COPY FACILITY

		COST	BENFT
1	CENTRAL ONLY (COLOR)	0	0
2	CENTRAL + B/W LOCAL	5000	90
3	CENTRAL+COLOR LOCAL	10000	100
	WITHIN CRITERION WEIGHTS		35

Table 3-3

ASSESSED COSTS AND BENEFITS FOR SGWS SITE MODEL

needed to operate the system, and inclusion of a staff would not add any value to the system.

For the reasons mentioned above, the benefit from addition of staff control may be viewed as a multiplier of the benefits of the SGWS. Without a staff, SGWS enhancements have no benefits, and the benefit multiplier is 0. With staff, however, SGWS enhancements may receive their full value, and the benefit multiplier is 1.0. The cost involved with staff control involves the duplicate equipment which must be purchased to allow staff constrol, including a preview monitor, keyboard, and intercom. The cost of these extra items was estimated to be $3500 per site.

3.2.3 Number of sites - In addition to the items mentioned above, the cost of a site includes an estimated $8000 fixed cost for local switching, microphones, furniture, wires, video switches, and lighting. The total cost of a number of sites is simply the product of the total site cost and the number of sites. Thus, number of sites involves no cost of its own, but is a cost multiplier in determining total cost.

Benefits derived from increasing the number of sites were judged to be greater if the sites were more sophisticated than if the sites were less sophisticated. Assessed benefits shown in Table 3-4 indicate that greater benefit may be obtained from increasing the number of sites from four to twelve than from increasing the sophisitication of the sites from the minimum to maximum level. However, greater benefit is obtained from the improvement in sophistication at twelve sites than is obtained from increasing the number of sites from twelve to thirty-five. The value of the benefits and benefit multipliers assigned to this variable reflect these judgments.

Site Sophistication	Number of Sites 4	8	12	35
Low-all Variables at Level 1	0	50	80	100
High-all Variables at Maximum	20	70	110	150

Table 3-4

ASSESSED BENEFITS FOR NUMBER OF SITES AS A FUNCTION OF SITE SOPHISTICATION

3.2.4 Central features - Both costs and benefits are independent for the variables of the central features model. These parameters are displayed in Table 3-5, and rationale for the benefits is presented in Appendix A-3. In addition to the costs associated with the Design variables, there was a fixed cost of $200,000 for central switching hardware, central processing, image control, and processing and control software.

3.3 Model Results

Because of the complexity of the interactions in surrogate design, the surrogate model was developed separately from other models. The cost-efficient surrogate designs were put into the overall design as levels of a single surrogate variable. The overall analysis identified total teleconference designs offering the greatest benefit for the cost expended.

3.3.1 Surrogate model results - There are thirty-two possible surrogate designs taken from all possible combinations of the four Design variables. Of these designs, the analysis identified eight as being on the cost-efficient frontier. The levels of the variables for these eight designs are shown in Table 3-6 in order of increasing cost and benefit. A plot of the costs and benefits of these designs is given in Figure 3-6.

Table 3-6 shows that the most cost-beneficial enhancements to surrogate quality are in the number of surrogates, followed by the implementation of virtual space and increase in the screen size. The introduction of color surrogates was the least cost-beneficial improvement, and hence was made only at a high level of investment. These eight designs were used as levels of a surrogate variable in the overall Design model.

VARIABLE 1: OPTICAL VIDEO DISK

		COST	BENFT
1	NONE	0	0
2	MANUAL (R/O)	4000	60
3	PROCESSOR (R/O)	25000	100

WITHIN CRITERION WEIGHTS 40

VARIABLE 2: MAG. VIDEO DISK

		COST	BENFT
1	NONE	0	0
2	BUY	30000	100

WITHIN CRITERION WEIGHTS 100

VARIABLE 3: VIDEOTAPE

		COST	BENFT
1	NONE	0	0
2	BUY	2500	100

WITHIN CRITERION WEIGHTS 80

Table 3-5

ASSESSED COSTS AND BENEFITS FOR CENTRAL FEATURES MODEL

Number of Surrogates	Virtual Space	B/w Color	Size	Cost	Benefit
2	No	BW	Small	1000	0
3	No	BW	Small	1600	32
4	No	BW	Small	2000	47
3	Yes	BW	Small	2400	58
3	Yes	BW	Large	3000	74
4	Yes	BW	Large	4000	89
5	Yes	BW	Large	5000	95
5	Yes	BW	Large	9000	100

Table 3-6

COST AND BENEFIT OF OPTIMAL CONFEREE SURROGATE DESIGNS

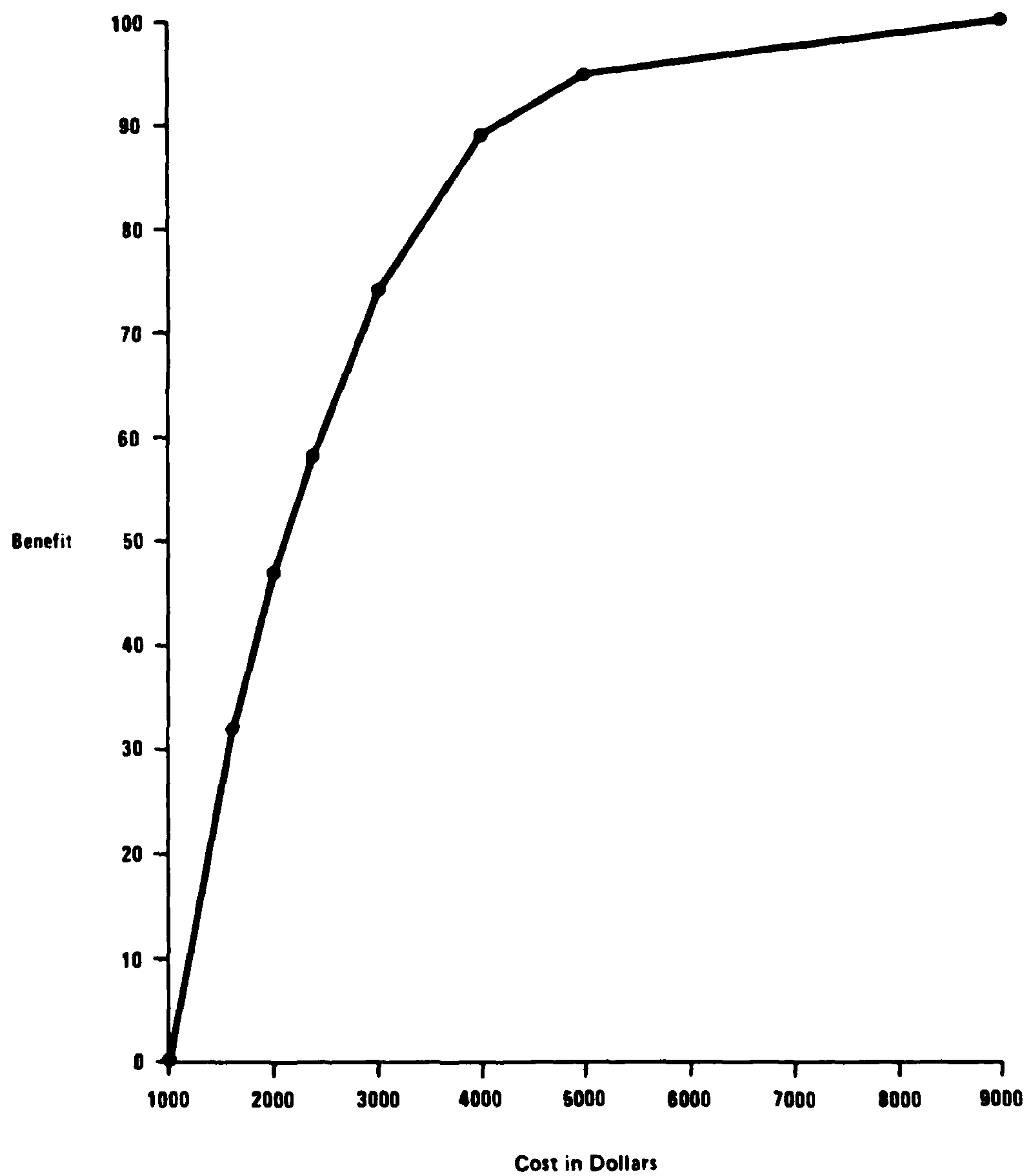

Figure 3-6
PLOT OF COSTS AND BENEFITS FOR COST-EFFICIENT SURROGATE DESIGNS

3.3.2 Overall model assessments - In order to perform the required analysis, it is necessary to assess for each level of each variable the four parameters, that is, fixed costs and benefit, and cost and benefit multipliers. The assessed values of these parameters are shown in Table 3-7. These values represent the judgments described in Section 3.2. In addition, two judgments were made by MRAL personnel relating the benefits obtained in the central features, surrogate features, and SGWS features. The first judgment was that the swing from the lowest to the highest level in the surrogate design was worth 2.5 times as much as the swing from the least to the most sophisticated SGWS design. Thus, if surrogate level receives a weight of 100, the total weight received by all SGWS factors is 40. The second judgment was that the magnetic video disk in central features is worth about 70% as much as the primary monitor for the SGWS. The primary monitor weight was calculated assuming staff control and thirty-five sites. Site and central fixed costs are included in variables 12 and 3, respectively.

3.3.3 Cost-efficient alternatives - The Design model identified twenty-eight cost-efficient teleconference designs with costs ranging from $245K to $3.6M. The costs and benefits of these designs, shown in Figure 3-7, indicate that there are great differences in the cost-effectiveness of enhancements in difference areas. As a result, is is possible to obtain a large proportion of the benefit of teleconferencing from a relatively small investment. The details of each cost-efficient package are presented in Appendix B. This section examines three packages varying in sophistication and cost, and makes generalizations about the cost-effectiveness of enhancements to teleconferencing in various areas.

The three designs examined in this section vary in cost from $345,900 to $1,797,500. They were chosen

VAR 1: OPTICAL VIDEO DISK

	COST	COST MULT	BENEFIT	BEN MULT
NONE	0	1.00	.00	1.00
MANUAL (R/O)	4000	1.00	1.05	1.00
PROCESSOR (R/O)	25000	1.00	1.75	1.00

VM READ

VAR 2: MAG. VIDEO DISK

	COST	COST MULT	BENEFIT	BEN MULT
NONE	0	1.00	.00	1.00
BUY	30000	1.00	4.38	1.00

VM READ

VAR 3: VIDEOTAPE

	COST	COST MULT	BENEFIT	BEN MULT
NONE	200000	1.00	.00	1.00
BUY	202500	1.00	3.51	1.00

VM READ

VAR 4: NUMBER OF SITES

	COST	COST MULT	BENEFIT	BEN MULT
FOUR	0	4.00	.00	.14
EIGHT	0	8.00	50.00	.14
TWELVE	0	12.00	80.00	.21
THIRTY-FIVE	0	35.00	100.00	.36

VM READ

VAR 5: SURROGATE LEVEL

	COST	COST MULT	BENEFIT	BEN MULT
2 NO BW SMALL	1000	1.00	.00	1.00
3 NO BW SMALL	1600	1.00	32.00	1.00
4 NO BW SMALL	2000	1.00	47.00	1.00
3 VS BW SMALL	2400	1.00	58.00	1.00
3 VS BW LARGE	3000	1.00	74.00	1.00
4 VS BW LARGE	4000	1.00	89.00	1.00
5 VS BW LARGE	5000	1.00	95.00	1.00
5 VS COLOR LARGE	9000	1.00	100.00	1.00

VM READ

VAR 6: CONTROL LOCUS

	COST	COST MULT	BENEFIT	BEN MULT
PRINCIPAL	0	1.00	.00	.00
STAFF	3500	1.00	.00	1.00

Table 3-7

ASSESSED VALUES FOR PARAMETERS

VAR 7: SWITCHING/INPUT

	COST	COST MULT	BENEFIT	BEN MULT
HARD SWITCHING	0	1.00	.00	1.00
+ KEYBOARD	1000	1.00	4.17	1.00
+ TOUCHSCREEN	3000	1.00	9.39	1.00
+ DATA TABLET	4500	1.00	10.43	1.00

VM READ

VAR 8: PRIMARY MONITOR

	COST	COST MULT	BENEFIT	BEN MULT
B/W SIMPLE RASTER	2300	1.00	.00	1.00
COLOR SIMPLE RASTER	3400	1.00	3.48	1.00
B/W FRAME BUFFER	14000	1.00	10.43	1.00
COLOR FRAME BUFFER	15000	1.00	17.39	1.00

VM READ

VAR 9: PREVIEW MONITOR

	COST	COST MULT	BENEFIT	BEN MULT
NONE	0	1.00	.00	1.00
B/W SIMPLE RASTER	800	1.00	.87	1.00
COLOR SIMPLE RASTER	1200	1.00	1.13	1.00
B/W FRAME BUFFER	14000	1.00	1.48	1.00
COLOR FRAME BUFFER	15000	1.00	1.74	1.00

VM READ

VAR 10: CONTROL MONITOR

	COST	COST MULT	BENEFIT	BEN MULT
NONE	0	1.00	.00	1.00
ALPHANUMERIC	500	1.00	3.48	1.00

VM READ

VAR 11: STORAGE FACILITY

	COST	COST MULT	BENEFIT	BEN MULT
CENTRAL ONLY	0	1.00	.00	1.00
CENTRAL AND LOCAL	30000	1.00	.87	1.00

VM READ

VAR 12: HARD COPY FACILITY

	COST	COST MULT	BENEFIT	BEN MULT
CENTRAL ONLY (COLOR)	8000	1.00	.00	1.00
CENTRAL + B/W LOCAL	13000	1.00	5.48	1.00
CENTRAL+COLOR LOCAL	18000	1.00	6.09	1.00

Table 3-7

ASSESSED VALUES FOR PARAMETERS (Cont'd)

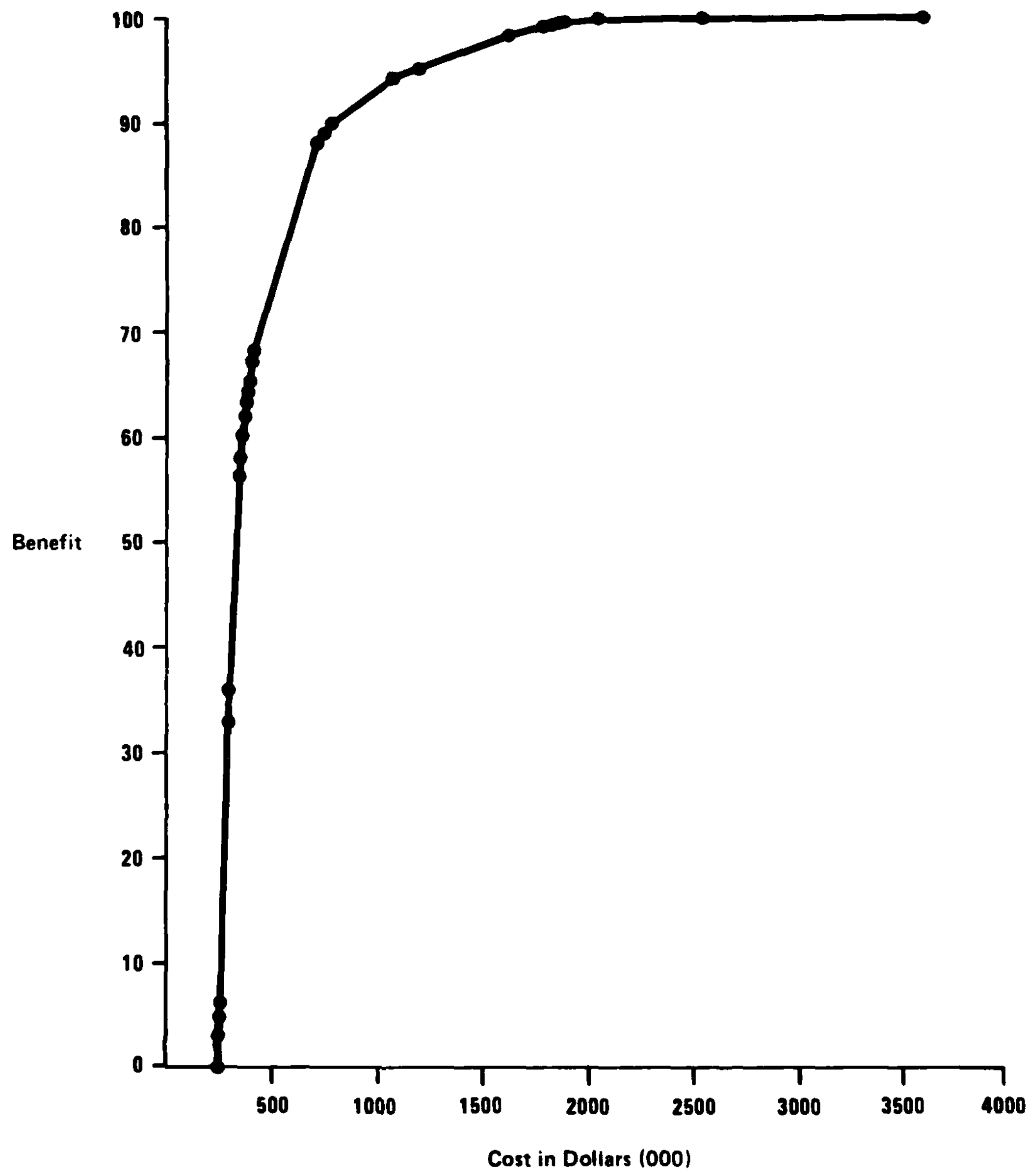

Figure 3-7
PLOT OF COSTS AND BENEFITS FOR COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS

because the package of features they offer seemed reasonable when compared to the needs of MRAL. The least expensive and sophisticated of the designs does not include any enhancements to the SGWS, but offers some sophistication in the surrogate design. The mid-level design offers staff control and some SGWS enhancements. The most expensive design includes all features except the least cost-beneficial.

Table 3-8 shows a system costing only $100K more than the minimal system that offers 60% of the relative benefit. This system involves twelve sites. The only central feature purchased is the videotape recorder. Although the videotape offers lower benefit than the magnetic video disk, its much lower cost makes it a better buy. The individual sites contain three conferee surrogates, each with its own camera to permit eye contact. However, the surrogates are small BW monitors. No improvements have been made to the SGWS.

A more sophisticated design, shown in Table 3-9, would cost about $1.1M and would offer several enhancements to the SGWS. These enhancements include keyboard and touchscreen input, a color primary monitor, and an alphanumeric control monitor. In order to obtain the benefits from the enhanced SGWS, a staff station was added to aid in system control. This particular design is the least expensive cost-efficient design in which there are any improvements to the SGWS. The facts that several improvements were made simultaneously and that staff control was purchased along with these improvements reflect the judgments that staff control was necessary to obtain any of the benefits from SGWS enhancements. Since the cost of staff control does not depend on the number of features controlled, the purchase of staff control becomes cost-efficient only if there are several features over which the cost may be divided.

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	TWELVE	: 3 OF 4
SURROGATE LEVEL	3 VS BW SMALL	: 4 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 95.69 (60 PCT OF MAX)
COST: 354900 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Table 3-8

OPTIMAL LOW-COST DESIGN

```
THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK    PROCESSOR (R/O)       : 3 OF 3
MAG. VIDEO DISK       BUY                   : 2 OF 2
VIDEOTAPE             BUY                   : 2 OF 2
NUMBER OF SITES       THIRTY-FIVE           : 4 OF 4
SURROGATE LEVEL       5 VS BW LARGE         : 7 OF 8
CONTROL LOCUS         STAFF                 : 2 OF 2
SWITCHING/INPUT       + TOUCHSCREEN         : 3 OF 4
PRIMARY MONITOR       COLOR SIMPLE RASTER   : 2 OF 4
PREVIEW MONITOR       NONE                  : 1 OF 5
CONTROL MONITOR       ALPHANUMERIC          : 2 OF 2
STORAGE FACILITY      CENTRAL ONLY          : 1 OF 2
HARD COPY FACILITY    CENTRAL ONLY (COLOR)  : 1 OF 3

BENEFIT: 149.726  (94 PCT OF MAX)
COST:    1076500  (30 PCT OF MAX)
THE EXCESS RESOURCE IS 0
```

Table 3-9

OPTIMAL MID-COST DESIGN

In terms of numbers of sites, central features, and surrogate quality, the design was at or near the highest level for all variables. Specifically, all central features are bought, there are thirty-five sites, and there are five large, BW surrogates, each with its own camera to allow for eye contact. The result which indicates that surrogate quality is improved before SGWS quality reflects both the judgment that improvements in the surrogates were more beneficial and the fact that the improvements in the surrogates are less costly than those in the SGWS.

Table 3-10 shows a design in which almost all enhancements have been made. This design gives 99% of the potential benefits for a cost of $1.8M. The features not included in this design are those which are prohibitively cost-inefficient. These features are the color local hard-copy facility, the local magnetic video disk, the preview monitor, and the data tablet. The preview monitor and the magnetic video disk were not included chiefly because of their extremely high cost. The other two features have a reasonable cost but do not provide great benefit in addition to features already present in the system.

Several generalizations may be made from the cost-efficient designs described above and in Appendix B. First, the quality of the surrogates is enhanced to a high level considerably before any improvements are made in the SGWS. This result is reasonable when one considers the judgments made of both cost and benefit in the two areas. Specifically, the improvements in the surrogates were judged to be 2.5 times more beneficial than those in the SGWS. Also, the surrogate enchancements were obtained at a considerably lower cost than those in the SGWS. In addition to these considerations is the fact that SGWS improvements require the addition of a staff to operate them. The necessity of staff control further increases the cost of SGWS enhancements.

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	:	3 OF 3
MAG. VIDEO DISK	BUY	:	2 OF 2
VIDEOTAPE	BUY	:	2 OF 2
NUMBER OF SITES	THIRTY-FIVE	:	4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	:	8 OF 8
CONTROL LOCUS	STAFF	:	2 OF 2
SWITCHING/INPUT	+ TOUCHSCREEN	:	3 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	:	4 OF 4
PREVIEW MONITOR	NONE	:	1 OF 5
CONTROL MONITOR	ALPHANUMERIC	:	2 OF 2
STORAGE FACILITY	CENTRAL ONLY	:	1 OF 2
HARD COPY FACILITY	CENTRAL + B/W LOCAL	:	2 OF 3

BENEFIT: 158.5064 (99 PCT OF MAX)
COST: 1797500 (50 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Table 3-10

OPTIMAL HIGH-COST DESIGN

A second generalization is that the number of sites is increased to 35 at a relatively low cost. In fact, the improvement to thirty-five sites is made at a lower cost than the introduction of any SGWS improvements. This result is consistent with the judgment that improvements in site quality are worth half as much as those in number of sites. In addition, the quality improvements are worth less if there are fewer than thirty-five sites.

Finally, central features are introduced at a relatively low cost. The early introduction of central features results from the fact that these costs are shared among sites. Thus as the number of sites increases, the central features become increasingly cost-beneficial.

3.4 Sensitivity Analyses

Section 3.3 described the results and identified some of the assessments that were critical in producing them. In this section, these critical assessments will be varied, and the results will be examined. The three critical assessments which will be examined are:

- o the weight of SGWS factors relative to surrogate quality;
- o the weight of site quality relative to number of sites; and
- o the costs associated with staff control.

Three dependent variables will be used in this sensitivity analysis: (1) are the cost at which the number of sites is increased to thirty-five, (2) the cost at which the first improvement is made in the SGWS, and (3) the cost at which the last improvement is made in the surrogate quality.

To perform the sensitivity analyses, the model was run three additional times with changes in the parameter estimates of the model reflecting changes in the assumptions described above. The specific changes in each of the runs are described below:

- For the first run, the weight of the SGWS enhancements was changed from 40% of that of surrogate quality to the same as that of surrogate quality.

- For the second run, the weight of site quality was changed from 50% of that for number of sites (at thirty-five sites) to the same as that for number of sites. This change involved doubling the benefit multipliers for number of sites.

- For the third run, staff control was assumed; the cost of staff was considered a fixed cost to make costs equivalent.

The results of these three analyses are presented in Table 3-11. The results indicate that there is little sensitivity to relatively large differences in these critical assessments. Results of each sensitivity analysis are discussed below.

Making SGWS quality as important as the quality of the surrogates has little impact on when improvements are made in the SGWS compared to improvements in the surrogate or an increase in the number of sites. As in the original model, the first SGWS improvement occurs after the purchase of thirty-five sites when the surrogate variable is at its penultimate level. The SGWS enhancement occurs before the processor is added to the optical video disk, as opposed to after in the original analysis. Also, the last improvement in the surrogate occurs much later in the analysis with revised weights.

	Cost At Which Change Occurs		
Weights	35 Sites	1st SGWS Enhancement	Last Surrogate Enhancement
Original Weight	$737,000	$1,076,500	$1,216,500
Increased Weight for SGWS	$737,000	$1,055,500	$1,892,000
Increased Weight for Site Quality	$737,000	$1,076,500	$1,216,500
Assume Staff Control	$859,500	$456,100	$1,216,500

Table 3-11

RESULTS OF SENSITIVITY ANALYSES ON CRITICAL ASSESSMENTS

The relative weight of number of sites and site quality seems to have little impact on the results of the analysis. In fact, none of the three costs of interest were changed by changes in this assessment.

Changing the assumptions about the staff seems to have the greatest impact on the results of the analysis. However, careful interpretation of these changes shows them to be smaller than they would appear at first glance. Since staff control is assumed, the cost of individual sites is somewhat higher than in the other analyses. Hence, the increase to thirty-five sites occurs at a somewhat higher cost. The first SGWS improvement occurs at a much lower cost here than in the original analysis. However, since the benefit of the SGWS features is not tied to the existance of the staff control, SGWS features are added singly, rather than as a group of simultaneous enhancements. The first change, the purchase of an alphanumeric control monitor, occurs much earlier than in the other analyses. However, the next change, the addition of keyboard input, occurs at $947K, after the move to thirty-five sites.

Sensitivity analyses indicate that the results of the analysis are relatively insensitive to changes in the critical assessments of the Design model. Consequently, one may be reasonably confident of the recommendations of the model; these recommendations indicate that central features, number of sites, and surrogate quality all offer areas in which relatively cost-efficient enhancements may be made to a teleconference system. Enhancements to the SGWS are less attractive, however, because of the relatively high cost, compared to the benefit obtained.

4.0 CONCLUSIONS AND RECOMMENDATIONS

The previous analyses have identified areas in teleconference system design offering the greatest benefit for the cost. Results indicate several cost-beneficial areas in central features and surrogate design for enhanced performance. Enhancements in the SGWS, in general, offer less value for the cost than the other areas. Nevertheless, those areas of the SGWS providing the most attractive investment were identified.

The Design analysis considered the relative benefit of a number of teleconference system designs. This analysis is not sufficient to determine whether MRAL should purchase a teleconference system, and how much money should be spent for such a system. Such a decision would be aided by a model comparing various teleconference systems to alternative systems which do not involve video teleconferencing. One task which will be accomplished on the remainder of this effort is to develop such a model. This model will document the benefits of a small number of well-chosen teleconference systems in a way that will help MRAL personnel determine whether or not the costs of any teleconference system are justified by the benefits provided by the system.

In addition to the above modeling effort, more detailed cost estimates will be obtained for a specific teleconference system. These estimates will detail the equipment, installation, and operations costs involved in the first three years after the system is purchased. Specifying these costs will provide a reasonable transition plan for the purchase of a video teleconference system.

APPENDIX A

RATIONALE FOR BENEFITS OF TELECONFERENCE DESIGN VARIABLES

VARIABLE 1: NUMBER SURROGATES

CRITERION: BENFT			
1	2	3	4
0	60	90	100

With two surrogates only three individuals may participate in any teleconference. Some conferences in MRAL are this small (such as those involving the PDASD, one DASD, and one outside person), but this system would operate only in a closed environment.

Going to three or four surrogates increases greatly the flexibility of the system to handle larger conferences. Four surrogates allows meetings involving five people; it was felt that this represents a reasonable maximum for the number of conferees at a meeting.

Going to five surrogates would have a small improvement in flexibility. In addition, the large number of monitors may lead to some confusion and slightly lower performance. The net improvement is small.

VARIABLE 2: VIRTUAL SPACE

CRITERION: BENFT	
1	2
0	100

Virtual Space allows eye contact among the conferees. Eye contact makes the teleconference more realistic, and leads to smoother, more efficient meetings. The symmetric arrangement of surrogates required for Virtual Space may prove somewhat inconvenient if there is a large number of surrogates. In that case, surrogate position may deviate from that dictated by Virtual Space. However, each surrogate will have its own camera to maintain eye contact.

Appendix A-1

SURROGATES MODEL

VARIABLE 3: BW/COLOR

CRITERION: BENFT

1	2
0	100

Color monitors on the conferee surrogates leads to slightly better realism in teleconferences. This difference is less than the differences in other areas, however.

VARIABLE 4: SIZE

CRITERION: BENFT

1	2
0	100

Large monitors leads to a much more realistic teleconference. The greatest realism occurs when the image is similar to its actual size. Seventeen- to nineteen-inch monitors provide fairly good realism.

Appendix A-1

SURROGATES MODEL (Cont'd)

VARIABLE 1: SWITCHING/ INPUT	CRITERION: BENFT			
	1	2	3	4
	0	40	90	100

Keyboard input allows alphanumeric input and provides for an easy, legible message facility. Problem: requires user to know how to type.

Addition of a touchscreen allows the user additional features, such as highlighting of areas of interest on displays, simplified menu selection for control, and enhanced written communication among users.

The data tablet adds higher resolution input for greater capability for shared blackboard which does not interfere with graphic display.

VARIABLE 2: PRIMARY MONITOR	CRITERION: BENFT			
	1	2	3	4
	0	20	60	100

Assume screen size is 15".
Color would be useful for differentiating information sources, highlighting information, focusing attention, etc.

Frame buffer allows you to integrate analog and digital sources; local storage of freeze-frame images. Without frame buffer, some kinds or combinations of information would be impossible or overly expensive.

With frame buffer, color is worth more because of capabilities for color coding, complex manipulations, etc.

Appendix A-2

SGWS MODEL

VARIABLE 3: PREVIEW MONITOR — CRITERION: BENFT

1	2	3	4	5
0	50	65	85	100

Without preview monitor, could still preview information on the main screen, using a button or switch. Having a separate preview monitor allows uninterrupted access to the main display, and simplifies operations (fewer controls to manipulate).

Becuase preview monitor does not need to mix multiple-source information as critically, frame buffer and color both become less important, and both interact less. Frame buffer is still more important than color, because the main concern is overall content, rather than detail; you would still benefit from being able to integrate digital and analog inputs (e.g., video image and touch screen inputs).

VARIABLE 4: CONTROL MONITOR — CRITERION: BENFT

1	2
0	100

Alphanumeric monitor for menu listing, messages, etc.
Would involve input from touch screen, data tablet, or keyboard.

Main value would be to avoid clutter on primary screen.

Appendix A-2

SGWS MODEL (Cont'd)

VARIABLE 5: STORAGE FACILITY

CRITERION: BENFT

1	2
0	100

Magnetic video disk at local site to permit individual conferrees to obtain a personal record of displaysfor subsequent access or documentation.

Reliability would be higher because of redundancy, independence of central routing facility; also, psychological advantage of "owning" personal record. Privacy might be an advantage.

VARIABLE 6: HARD COPY FACILITY

CRITERION: BENFT

1	2	3
0	90	100

Local hard copy facilities will be used to augment the capability of a central high-resolution color hard copy facility with manual dissemination.

Because the primary benefit will come from immediate access to local copies, b/w will be sufficient for the vast majority of cases (only certain color displays which do not copy well into b/w would be adversely affected).

Appendix A-2

SGWS MODEL (Cont'd)

VARIABLE 7: CONTROL LOCUS

CRITERION: BENFT

1	2
0	0

Staff communications would have an intercom, preview screen, and keyboard; principal would have the same installation as before.

Principal does not need to learn mechanics of information manipulation with staff control. Principal would be free to participate in conference without need to search for input data, computer items, etc., but principal needs to depend on staff's performance. Staff would have little if any benefit for the baseline system. However, staff control is necessary to obtain the benefits of site sophistication.

Appendix A-2

SGWS MODEL (Cont'd)

VARIABLE 1: OPTICAL VIDEO DISK

CRITERION: BENFT		
1	2	3
0	60	100

The optical video disk could be used for storing and displaying large quantities of video data, such as maps, pictures, blueprints, and other items which could be prepared in advance. Since there is no write capability, the optical video disk would be most useful for fairly static information.

The large strorage capacity of a video disk (54K frames) makes processor control very helpful in deriving full benefit from the video disk.

VARIABLE 2: MAG. VIDEO DISK

CRITERION: BENFT	
1	2
0	100

The magnetic video disk provides the capability to store and retrieve information in video format. One use for this device would be to save the images on the SGWS for use at later conferences, or to serve as a summary of meeting accomplishments. Another use would be as a storage device for briefing materials.

Appendix A-3

CENTRAL FEATURES MODEL

CENTRAL FEATURES MODEL   TUESDAY 9/16/1980 13:20

VARIABLE 3: VIDEOTAPE   CRITERION: BENFT

	1	2
	0	100

Videotape would be used to provide a record of critical conferences, to present recorded briefings and other information for which it is sufficient to view material sequentially. Although videotape does not provide random access, as does video disk, the process involved in making a videotape is much simpler and less time consuming than the process involved in video-disk production.

Appendix A-3

CENTRAL FEATURES MODEL (Cont'd)

APPENDIX B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	NONE	: 1 OF 2
NUMBER OF SITES	FOUR	: 1 OF 4
SURROGATE LEVEL	2 NO BW SMALL	: 1 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 0 (0 PCT OF MAX)
COST: 245200 (7 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	NONE	: 1 OF 2
NUMBER OF SITES	FOUR	: 1 OF 4
SURROGATE LEVEL	3 NO BW SMALL	: 2 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 4.48 (3 PCT OF MAX)
COST: 247600 (7 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	FOUR	: 1 OF 4
SURROGATE LEVEL	3 NO BW SMALL	: 2 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 7.99 (5 PCT OF MAX)
COST: 250100 (7 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	FOUR	: 1 OF 4
SURROGATE LEVEL	4 NO BW SMALL	: 3 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 10.09 (6 PCT OF MAX)
COST: 251700 (7 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	EIGHT	: 2 OF 4
SURROGATE LEVEL	2 NO BW SMALL	: 1 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 53.51 (33 PCT OF MAX)
COST: 292900 (8 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	EIGHT	: 2 OF 4
SURROGATE LEVEL	3 NO BW SMALL	: 2 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 57.99 (36 PCT OF MAX)
COST: 297700 (8 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	TWELVE	: 3 OF 4
SURROGATE LEVEL	3 NO BW SMALL	: 2 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 90.23 (56 PCT OF MAX)
COST: 345300 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	TWELVE	: 3 OF 4
SURROGATE LEVEL	4 NO BW SMALL	: 3 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 93.38 (58 PCT OF MAX)
COST: 350100 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	: 1 OF 3
MAG. VIDEO DISK	NONE	: 1 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	TWELVE	: 3 OF 4
SURROGATE LEVEL	3 VS BW SMALL	: 4 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 95.69 (60 PCT OF MAX)
COST: 354900 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	1 OF 3
MAG. VIDEO DISK	NONE	1 OF 2
VIDEOTAPE	BUY	2 OF 2
NUMBER OF SITES	TWELVE	3 OF 4
SURROGATE LEVEL	3 VS BW LARGE	5 OF 8
CONTROL LOCUS	PRINCIPAL	1 OF 2
SWITCHING/INPUT	HARD SWITCHING	1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	1 OF 4
PREVIEW MONITOR	NONE	1 OF 5
CONTROL MONITOR	NONE	1 OF 2
STORAGE FACILITY	CENTRAL ONLY	1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	1 OF 3

BENEFIT: 99.05 (62 PCT OF MAX)
COST: 362100 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	MANUAL (R/O)	2 OF 3
MAG. VIDEO DISK	NONE	1 OF 2
VIDEOTAPE	BUY	2 OF 2
NUMBER OF SITES	TWELVE	3 OF 4
SURROGATE LEVEL	3 VS BW LARGE	5 OF 8
CONTROL LOCUS	PRINCIPAL	1 OF 2
SWITCHING/INPUT	HARD SWITCHING	1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	1 OF 4
PREVIEW MONITOR	NONE	1 OF 5
CONTROL MONITOR	NONE	1 OF 2
STORAGE FACILITY	CENTRAL ONLY	1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	1 OF 3

BENEFIT: 100.1 (63 PCT OF MAX)
COST: 366100 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	NONE	1 OF 3
MAG. VIDEO DISK	NONE	1 OF 2
VIDEOTAPE	BUY	2 OF 2
NUMBER OF SITES	TWELVE	3 OF 4
SURROGATE LEVEL	4 VS BW LARGE	6 OF 8
CONTROL LOCUS	PRINCIPAL	1 OF 2
SWITCHING/INPUT	HARD SWITCHING	1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	1 OF 4
PREVIEW MONITOR	NONE	1 OF 5
CONTROL MONITOR	NONE	1 OF 2
STORAGE FACILITY	CENTRAL ONLY	1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	1 OF 3

BENEFIT: 102.2 (64 PCT OF MAX)
COST: 374100 (10 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

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THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK    MANUAL (R/O)           : 2 OF 3
MAG. VIDEO DISK       NONE                   : 1 OF 2
VIDEOTAPE             BUY                    : 2 OF 2
NUMBER OF SITES       TWELVE                 : 3 OF 4
SURROGATE LEVEL       4 VS BW LARGE          : 6 OF 8
CONTROL LOCUS         PRINCIPAL              : 1 OF 2
SWITCHING/INPUT       HARD SWITCHING         : 1 OF 4
PRIMARY MONITOR       B/W SIMPLE RASTER      : 1 OF 4
PREVIEW MONITOR       NONE                   : 1 OF 5
CONTROL MONITOR       NONE                   : 1 OF 2
STORAGE FACILITY      CENTRAL ONLY           : 1 OF 2
HARD COPY FACILITY    CENTRAL ONLY (COLOR)   : 1 OF 3

BENEFIT: 103.25  (65 PCT OF MAX)
COST:    378100  (11 PCT OF MAX)
THE EXCESS RESOURCE IS 0


THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK    MANUAL (R/O)           : 2 OF 3
MAG. VIDEO DISK       BUY                    : 2 OF 2
VIDEOTAPE             BUY                    : 2 OF 2
NUMBER OF SITES       TWELVE                 : 3 OF 4
SURROGATE LEVEL       4 VS BW LARGE          : 6 OF 8
CONTROL LOCUS         PRINCIPAL              : 1 OF 2
SWITCHING/INPUT       HARD SWITCHING         : 1 OF 4
PRIMARY MONITOR       B/W SIMPLE RASTER      : 1 OF 4
PREVIEW MONITOR       NONE                   : 1 OF 5
CONTROL MONITOR       NONE                   : 1 OF 2
STORAGE FACILITY      CENTRAL ONLY           : 1 OF 2
HARD COPY FACILITY    CENTRAL ONLY (COLOR)   : 1 OF 3

BENEFIT: 107.63  (67 PCT OF MAX)
COST:    408100  (11 PCT OF MAX)
THE EXCESS RESOURCE IS 0


THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK    MANUAL (R/O)           : 2 OF 3
MAG. VIDEO DISK       BUY                    : 2 OF 2
VIDEOTAPE             BUY                    : 2 OF 2
NUMBER OF SITES       TWELVE                 : 3 OF 4
SURROGATE LEVEL       5 VS BW LARGE          : 7 OF 8
CONTROL LOCUS         PRINCIPAL              : 1 OF 2
SWITCHING/INPUT       HARD SWITCHING         : 1 OF 4
PRIMARY MONITOR       B/W SIMPLE RASTER      : 1 OF 4
PREVIEW MONITOR       NONE                   : 1 OF 5
CONTROL MONITOR       NONE                   : 1 OF 2
STORAGE FACILITY      CENTRAL ONLY           : 1 OF 2
HARD COPY FACILITY    CENTRAL ONLY (COLOR)   : 1 OF 3

BENEFIT: 108.89  (68 PCT OF MAX)
COST:    420100  (12 PCT OF MAX)
THE EXCESS RESOURCE IS 0
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Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	MANUAL (R/O)	: 2 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	4 VS BW LARGE	: 6 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 140.98 (88 PCT OF MAX)
COST: 737000 (20 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	MANUAL (R/O)	: 2 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS BW LARGE	: 7 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 143.14 (89 PCT OF MAX)
COST: 772000 (21 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS BW LARGE	: 7 OF 8
CONTROL LOCUS	PRINCIPAL	: 1 OF 2
SWITCHING/INPUT	HARD SWITCHING	: 1 OF 4
PRIMARY MONITOR	B/W SIMPLE RASTER	: 1 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	NONE	: 1 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 143.84 (90 PCT OF MAX)
COST: 793000 (22 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS BW LARGE	: 7 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ TOUCHSCREEN	: 3 OF 4
PRIMARY MONITOR	COLOR SIMPLE RASTER	: 2 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 149.726 (94 PCT OF MAX)
COST: 1076500 (30 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ TOUCHSCREEN	: 3 OF 4
PRIMARY MONITOR	COLOR SIMPLE RASTER	: 2 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 151.526 (95 PCT OF MAX)
COST: 1216500 (34 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ TOUCHSCREEN	: 3 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL ONLY (COLOR)	: 1 OF 3

BENEFIT: 156.5336 (98 PCT OF MAX)
COST: 1622500 (45 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ TOUCHSCREEN	: 3 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	NONE	: 1 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL + B/W LOCAL	: 2 OF 3

BENEFIT: 158.5064 (99 PCT OF MAX)
COST: 1797500 (50 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ TOUCHSCREEN	: 3 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	B/W SIMPLE RASTER	: 2 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL + B/W LOCAL	: 2 OF 3

BENEFIT: 158.8196 (99 PCT OF MAX)
COST: 1825500 (51 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ DATA TABLET	: 4 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	B/W SIMPLE RASTER	: 2 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL + B/W LOCAL	: 2 OF 3

BENEFIT: 159.194 (99 PCT OF MAX)
COST: 1878000 (52 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ DATA TABLET	: 4 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	COLOR SIMPLE RASTER	: 3 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL + B/W LOCAL	: 2 OF 3

BENEFIT: 159.2876 (100 PCT OF MAX)
COST: 1892000 (53 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ DATA TABLET	: 4 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	COLOR SIMPLE RASTER	: 3 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL+COLOR LOCAL	: 3 OF 3

BENEFIT: 159.5072 (100 PCT OF MAX)
COST: 2067000 (57 PCT OF MAX)
THE EXCESS RESOURCE IS 0

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	: 3 OF 3
MAG. VIDEO DISK	BUY	: 2 OF 2
VIDEOTAPE	BUY	: 2 OF 2
NUMBER OF SITES	THIRTY-FIVE	: 4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	: 8 OF 8
CONTROL LOCUS	STAFF	: 2 OF 2
SWITCHING/INPUT	+ DATA TABLET	: 4 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	: 4 OF 4
PREVIEW MONITOR	COLOR FRAME BUFFER	: 5 OF 5
CONTROL MONITOR	ALPHANUMERIC	: 2 OF 2
STORAGE FACILITY	CENTRAL ONLY	: 1 OF 2
HARD COPY FACILITY	CENTRAL+COLOR LOCAL	: 3 OF 3

BENEFIT: 159.7268 (100 PCT OF MAX)
COST: 2550000 (71 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)

THE ACTIVE PROJECTS AND THEIR OPTIMAL LEVELS ARE

OPTICAL VIDEO DISK	PROCESSOR (R/O)	:	3 OF 3
MAG. VIDEO DISK	BUY	:	2 OF 2
VIDEOTAPE	BUY	:	2 OF 2
NUMBER OF SITES	THIRTY-FIVE	:	4 OF 4
SURROGATE LEVEL	5 VS COLOR LARGE	:	8 OF 8
CONTROL LOCUS	STAFF	:	2 OF 2
SWITCHING/INPUT	+ DATA TABLET	:	4 OF 4
PRIMARY MONITOR	COLOR FRAME BUFFER	:	4 OF 4
PREVIEW MONITOR	COLOR FRAME BUFFER	:	5 OF 5
CONTROL MONITOR	ALPHANUMERIC	:	2 OF 2
STORAGE FACILITY	CENTRAL AND LOCAL	:	2 OF 2
HARD COPY FACILITY	CENTRAL+COLOR LOCAL	:	3 OF 3

BENEFIT: 160.04 (100 PCT OF MAX)
COST: 3600000 (100 PCT OF MAX)
THE EXCESS RESOURCE IS 0

Appendix B

LIST OF COST-EFFICIENT TELECONFERENCE SYSTEM DESIGNS (Cont'd)


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